MCR-80-509 (Issue 3)

EVALUATION AND PREDICTION OF LONG TERM SPACE ENVIRONMENTAL EFFECTS ON NON-METALLIC MATERIALS

CONTRACT NAS8-33578

QUARTERLY PROGRESS REPORT NO. 3

July 8, 1980

MeME 79/382M

by

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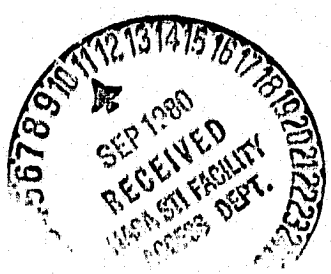

(NASA-CR-161545) EVALUATION AND PREDICTION OF LONG TERM SPACE ENVIRONMENTAL EFFECTS ON NON-METALLIC MATERIALS Quarterly Progress Report (Martin Marietta Corp.) 13 p
HC A02/MF A01

N80-30436

CSCL 07D G3/23

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28481

I. INTRODUCTION

The objective of this program is to determine the effects of prolonged space environment on a variety of spacecraft materials and where possible, compare these results with predicted behavior.

II. TECHNICAL PROGRESS SUMMARY

Task I - Physical properties testing

Ten materials have been evaluated for electrical and mechanical properties following long term vacuum exposure. This work is performed under subtask 1.1 in the revised schedule included with this report.

The materials tested during this reporting period are listed below.

MATERIAL	CLASSIFICATION	TESTS
FS-80	Molding compound	Dielectric Constant
Dow Corning 93-500	Silicone encapsulant	Dielectric Constant
Stycast 1090	Epoxy encapsulant	Dielectric Constant
Vespel SP-1	Polyimide	Dielectric Constant and Dielectric Strength
Dow Corning 6-1106	Sealant	180° Peel Strengtn
HT 435	Film adhesive	Shear Strength
Printed circuit board	Laminated plastic sheet	Flexure, Peel Strength of copper foil
Kapton F, 919	Electrical insulation	Tensile Strength
Kapton F, 011	Electrical insulation	Tensile Strength

The data obtained for these materials is presented in tabular form at the end of this report.

It is expected that subtask 1.1 will be completed during July.

Subtask 1.2 (irradiation exposure) cannot progress until a canister system has undergone calibration with the MSFC particle accelerator. This activity is currently underway at MSFC and timely completion is essential.

The fixture fabrication phase of subtask 1.3 is nearing completion. A trial assembly and leak test of the fixture is

scheduled for July.

Task II Perform TGA/RGA

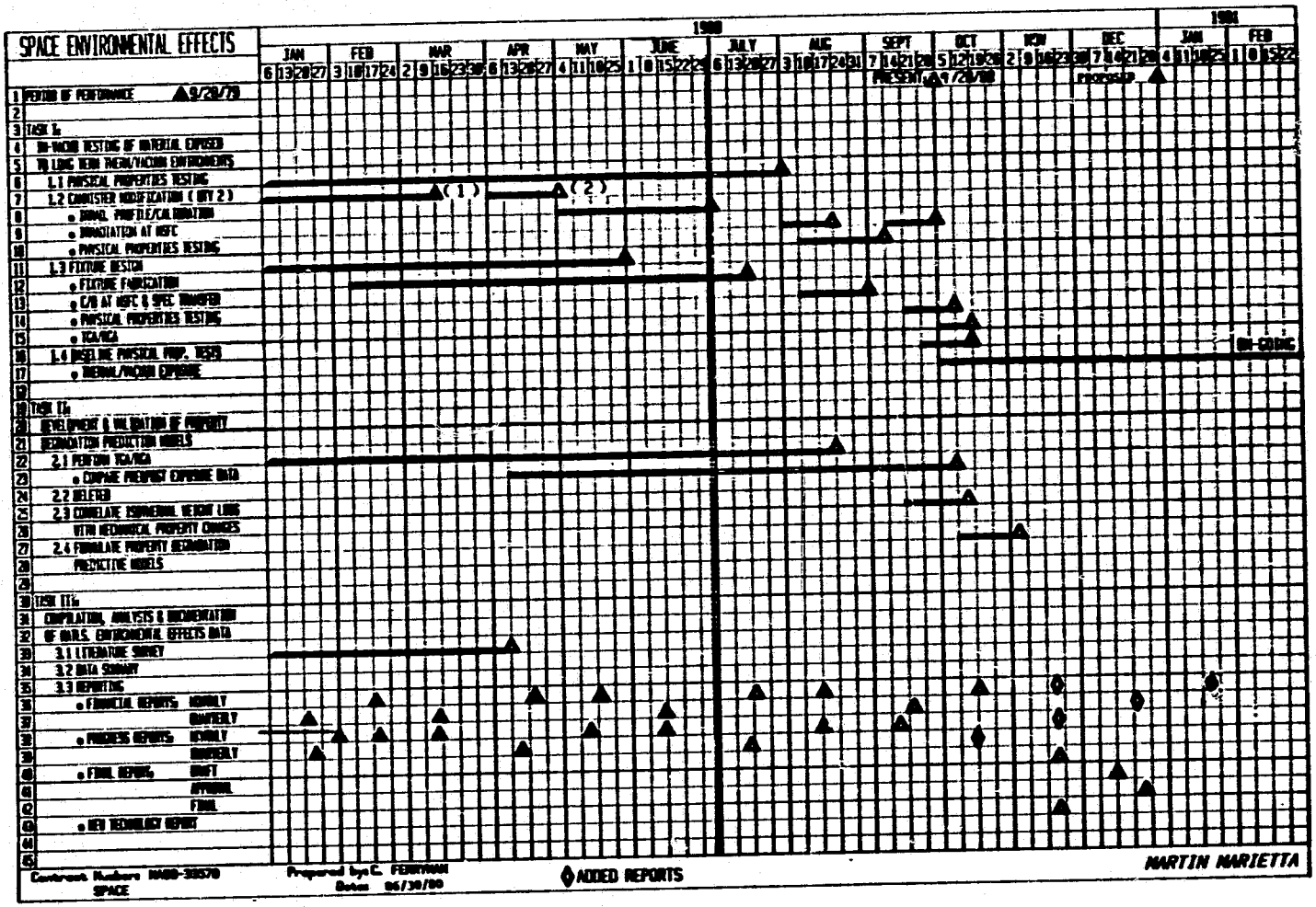
The TGA work continues in conjunction with the Task I physical properties effort. Real-time weight loss data will be available on 5 materials (Lexan, Lucite, Nylon, Polyethelene, Polyurethane) which should help greatly in performing subtask 2.3.

Task III Literature Survey

The literature survey is being edited and after corrections are made a copy will be sent to the technical personnel at MSFC per their request.

III. WORK PLANNED :

a) Complete subtask 1.1
b) Leak test manipulator adaptor system.
c) Compile real-time weight loss data.



Diall FS-80 Black, Mil-P-19833 Type GOI-30

Dielectric Constant (ASTM D150)
@ 1 MHZ

Exposure	Average	High	Low	Samples Tested
Baseline	3.79	3.81	3.78	3
Heat Compatibility (1)	3.60	3.69	3.40	3
Heat Compatibility (1) plus 30 day thermal vacuum (2)	3.43	3.57	3.33	3
Long Term Thermal Vacuum	3.49	3.49	3.49	2

Dissipation Factor (ASTM D150)
@ 1 MHZ

Baseline	0.012	0.013	0.012	3
Heat compatibility (1)	0.009	0.011	0.007	3
Heat compatibility (1) plus 30 day thermal vacuum (2)	0.002	0.003	0.001	3
Long Term Thermal Vacuum	.0043	.0043	.0043	2

(1) Heat compatibility -380 hours at 275°F (408°K) in N_2 atmosphere.

(2) Tested at $1x10^{-5}$ Torr after exposure for the specified length of time at 150°F (338°K) and $1x10^{-6}$ Torr.

Dow Corning 93-500
Dielectric Constant* (ASTM D150-68
@ 1MHZ

Exposure	Average	High	Low	Samples Tested
Baseline	2.79	2.81	2.78	3
Heat Compatibility(1)	2.76	2.78	2.74	3
Thermal Vacuum (2)	2.76	2.84	2.68	3
Long term Thermal Vacuum	2.70	2.74	2.65	3

*Cured 24 hours at room temperature plus 4 hours @ 65°C (338°K)

(1) 379 hours at 275°F (408°K) in N_2 atmosphere

(2) Tested at $1x10^{-5}$ Torr after 1100 hours at 150°F (338°K) at $1x10^{-6}$ Torr preceded by heat compatibility

STYCAST 1090/Cat. II
Dielectric Constant* (ASTM D150-68)
@ 1 KHZ

Exposure	Average	High	Low	Samples Tested
Baseline	2.89	2.94	2.84	3
Heat Compatibility (1)	2.82	2.85	2.79	3
Thermal Vacuum (2)	2.75	2.83	2.65	3
Long Term Thermal Vacuum	3.17	3.26	3.06	3

*Cured 4 hr at $150^{o}F$ ($338^{o}K$) plus 3 hr at $275^{o}F$ ($408^{o}K$)

(1) 383 hr at $275^{o}F$ ($408^{o}K$) in N_2 atmosphere

(2) Tested at $1x10^{-5}$ Torr after 750 hr at $150^{o}F$ ($338^{o}K$)
at $1x10^{-6}$ Torr preceded by heat compatibility

Vespel SP-1
Dielectric Constant (ASTM D150)
@ 1 MHZ

Exposure	Average	High	Low	Samples Tested
Baseline	2.94	2.98	2.90	3
Heat compatibility (1)	2.91	2.96	2.84	3
Heat compatibility (1) plus 30 day thermal vacuum (2)	2.87	2.92	2.84	3
Long Term Thermal Vacuum	2.44	2.51	2.35	3

Dissipation Factor (ASTM D150)
@ 1 MHZ

Baseline	0.00046	0.00047	0.00046	3
Heat compatibility (1)	0.00109	0.0011	0.00106	3
Heat compatibility (2) plus 30 day thermal vacuum (2)	0.00016	0.00016	0.00015	3
Long Term Thermal vacuum	.0013	0.0020	0.0011	3

(1) Heat compatibility - 750 hours at 275°F (408°K) in N_2 atmosphere.

(2) Tested at $1x10^{-5}$ Torr after exposure for the specified length of time at 150°F (338°K) and $1x10^{-6}$ Torr.

VESPEL SP-1

Dielectric Strength volts/mm (volts/mil)

Exposure	Nominal Thickness mm(mils)	Average	High	Low	Samples Tested
Baseline	1.6 (62)	27,000 (676)	28,000 (704)	26,000 (654)	5
Heat compatibility (1)	1.6 (62)	26,000 (666)	29,000 (742)	24,000 (622)	5
Heat compatibility (1) plus 30 day thermal vacuum (2)	1.6 (62)	19,000 (469)	21,000 (524)	15.000 (388)	5
Heat compatibility (1) plus 102 month thermal vacuum (2)	1.6 (62)	17,000 (443)	16,000 (405)	15,000 (387)	3

(1) 570 hoursat 275^{o} F (408^{o} K) in N_2 Atmosphere.

(2) Tested at 1×10^{-5} Torr after exposure for the specified length of time at 150^{o} F (338^{o} K) and 1×10^{-6} Torr.

Dow Corning 6-1106 Silicone Sealant
Lot # E1661-40

180° Peel Strength (ASTM D903)

Exposure	Peel Strength (lb/in) Average	High	Low	Samples Tested
Baseline	28	44	18	5
Baseline, Tested at 125°F	18	21	17	5
Baseline, Tested at -25°F	49	64	35	5
Heat Compatiblity (1)	40	42	36	5
Heat Compatiblity (1) plus 30 day thermal vacuum (2)	15.4	17.5	14.6	5
Heat Compatiblity (1) plus 103 months thermal vacuum (2)	14.0	15.5	12.5	5

(1) Heat compatibility - 570 hours at 275°F (408°K) in N_2 atmoshpere

(2) Tested at 10^{-5} Torr after exposure for the specified length of time at 150°F (338°K) and 10^{-6} Torr

HT 435 FILM ADHESIVE

Shear Strength (ASTM D1002), Adlock 851 adherends.

Exposure	Shear Strength, psi Average	High	Low	Samples Tested
Baseline	2040	2160	1940	9
Heat Compatibility (1)	2160	2240	2080	5
Heat Compatibility (1) plus 30 day thermal vacuum (2)	2100	2200	1900	5
Heat Compatibility (1) plus 97 month thermal vacuum (2)	1900	2060	1740	5

(1) Heat compatibility - 570 hours at 275°F (408°k) in N_2 atmosphere.

(2) Tested at 10^{-5} Torr after exposure for the specified length of time at 150°F (338°k) and 10^{-6} Torr.

Plastic Sheet, Copper Clad Laminate
Type GF, Grade-FB600 (Synthane-Taylor Corp.)

Peel Strength of Copper Foil (ASTM D1967)

Exposure	Peel Strength (lbs) Average	High	Low	Samples Tested
Baseline	1.85	1.90	1.82	11
Heat Compatibility (1)	1.57	1.68	1.50	12
Heat Compatibility (1) plus 30 day thermal vacuum (2)	1.53	1.60	1.50	12
Heat Compatibility (1) plus 97 month thermal vacuum (2)	1.69	2.10	1.50	20

(1) Heat compatibility - 570 hours at 275°F (408°K) in N_2 atmosphere

(2) Tested at 10^{-5} Torr after exposure for the specified length of time at 150°F (338°K) and 10^{-6} Torr.

Flexural Strength (ASTM D790)*

Exposure	Flexural Strength (psi) Average	High	Low	Samples Tested
Baseline	56,000	59,200	54,500	5
Heat Compatibility (1)	55,800	61,200	52,300	5
Heat compatibility (1) plus 30 day thermal vacuum (2)	64,600	65,900	63,700	5
Heat compatiblity plus 97 month thermal vacuum (20	66,400	68,300	64,800	5

* Procedure A, at a speed of 0.05 inches/minute with a 2 inch span using a 0.054 x 1 x 3 inch specimen.

(1) Heat compatiblity - 570 hours at 275°F (408°K) in N_2 atmosphere.

(2) Thermal vacuum - Tested at 10^{-5} Torr after exposure for the specified length of time at 150°F (338°K) and 10^{-6} Torr.

Kapton F, 919

Tensile Strength, ASTM D882

Exposure	Tensile Strength psi Average	High	Low	Samples Tested
Baseline	15,000	16,500	12,700	5
Heat Compatiblity (1)	14,400	16,400	13,400	5
Heat Compatibility (1) plus 30 day thermal vacuum (2)				
Heat Compatibility (1) plus 100 month Thermal Vacuum (2)	15,800	18,500	10,300	5

(1) Heat compatibility - 570 hours at 275°F (408°K) in N_2 atmosphere.

(2) Tested in air after exposure for the specified length of time at 150°F (338°K) and 10^{-6} Torr.

Kapton F 011

Tensile Strength, ASTM D882

Exposure	Tensile Strength psi Average	High	Low	Samples Tested
Baseline	13,400	16,400	10,200	5
Heat Compatiblity (1)	11,600	15,300	8,200	5
Heat Compatibility (1) plus 30 day Thermal Vacuum (2)				
Heat Compatibility (1) plus 100 month Thermal Vacuum (2)	12,200	15,000	8,400	5

(1) Heat Compatibility - 570 hours at 275°F (408°K) in N_2 atmosphere

(2) Tested in air after exposure for the specified length of time at 150°F (338°K) and 10^{-6} Torr.